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POLICY ANALYSIS

Climate adaptation in Coastal Virginia: an analysis of existing policies and main stakeholders

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ABSTRACT

The impacts of climate change have sparked policy responses at different governance levels. Studying the central adaptation policies and understanding the interactions and complexities of governmental and non-governmental stakeholders is essential in guiding policymakers at different levels of government to formulate policies and make investment decisions. With strategic and economic significance on the national level, Coastal Virginia has one of the highest rates of sea-level rise in the United States, instigating intensified and more frequent climate hazards such as flooding and storms. This paper strives to characterize the status of adaptation policymaking in this region through a novel keyword analysis method and a thematic analysis of interviews with the main adaptation decision-makers and stakeholders. We identify the central adaptation policies and programmes at the local, regional, state, and federal level, as well as the major relevant players. This provides a comprehensible narrative of adaptation policymaking, which could be exploited to further analyze governance gaps and adaptation challenges. The approach and methodologies of this research could be implemented in similar studies for other areas of the U.S. that are at high climate risk, possibly facilitating an informed national adaptation policy, long overdue by the federal government. The research is also relevant for other jurisdictions at risk of sea-level rise.

Key policy insights:

- Coastal adaptation policymaking in Virginia has been a bottom-up and fragmented process initiated by most affected localities, exhibiting the importance of local initiatives in higher-level adaptation policies.
- The long-lasting impacts of *100 Resilient cities* and *Dutch Dialogues* in the City of Norfolk highlight the value of fostering cross-geographic coordination and capacity-building programmes, confirming the importance of informal policy networks in learning and innovation for adaptation.
- There is a vast difference among localities in adaptation planning and implementation, creating the need for coordinating state leadership.
- Adaptation policymaking in Virginia has been influenced by political cycles with priorities drastically altered by each administration change, introducing significant uncertainty for continuation of policies.
- National policies and programmes, such as the Inflation Reduction Act of 2022, can significantly affect local-level policies and decision-making.

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1. Introduction

Anthropogenic climate change is a reality that will affect us on global and local scales for decades to millennia (Hansen & Stone, 2016). Specifically, sea levels are expected to rise by 0.3–1.2 metres from today's levels by

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2100. Sea-level rise (SLR) will be higher than the global average on the east and gulf coasts of the United States, which will increase the frequency and extent of extreme flooding associated with coastal storms (U.S. Global Change Research Program, 2018). Coastal areas are a critical part of the U.S. economy, comprising 42% of the population and employment, 48% of GDP, and 20% of the land area (USGCRP, 2020). According to climate risk assessments, on average $86 billion of U.S. coastal properties will be below sea level by 2050, increasing to $370 billion by 2100. Specifically, SLR could increase the annual damages from coastal storms and hurricanes on the eastern coast and the Gulf of Mexico by $108 billion (Gordon et al., 2014). In addition to private property risks, potential damages to coastal infrastructure, e.g. roads, bridges, tunnels, and pipelines, will result in cascading costs and national impacts (USGCRP, 2020). Coastal Virginia, home to 6 million people or 70% of the state's population, has one of the highest rates of SLR in the U.S. The sea-level in some coastal areas of the state is 0.4 metres higher than in 1950 (Boon, 2012; Kopp, 2013; NOAA, 2022). Virginia's Hampton Roads region has the second-largest population at risk of SLR in the U.S., after New Orleans (Eggleston & Pope, 2013).

The actual and projected impacts of climate change have sparked policy responses on different governance levels worldwide. Studying these policy responses and their implementation is vital to understanding the role of policies in mitigating climate risks. It is critical to understand the adaptation practice specific to an area by including the government systems and dynamics, as adaptation is primarily context-specific and local (Burton et al., 2002; Fünfgeld, 2015; Mullan et al., 2013; Preston et al., 2013). Studies to identify the central policies and stakeholders in adaptation are missing for Coastal Virginia, despite its high vulnerability. Our study aims to address this gap by characterizing the status of climate adaptation policymaking in Coastal Virginia in pursuit of answering the following research questions:

1. Who are the major players in coastal adaptation policymaking?
2. How are the climate risks perceived and addressed by the main stakeholders?
3. What are the most influential policies at the local, regional, state, and federal levels?

Characterizing climate adaptation policymaking by taking a comprehensive look into the governing policies and programmes is essential for identifying the key challenges to effective adaptation policies. This is necessary to guide local, regional, and state stakeholders in making and implementing climate risk management decisions. Moreover, while focused on Coastal Virginia, case studies such as this can be valuable in shaping broader adaptation policies, as they provide a learning opportunity by drawing implications from the experience of a specific region.

Some studies in the literature have investigated the barriers and challenges to coastal adaptation at different levels, usually through literature review, document analysis, surveys, and interviews (Baker et al., 2012; Larsen et al., 2011; Lin et al., 2017; Lubell, 2017; Ryan & Bustos, 2019; Shi et al., 2015; Williams et al., 2020; Yusuf & St. John, 2017). Other studies have primarily examined the current adaptation policies and influential stakeholders to understand the scope of adaptation and provide guidelines for a successful adaptation programmes (Blázquez et al., 2021; Hürlimann et al., 2022; Milhorance et al., 2020; Prasad & Sud, 2019; Westerhoff et al., 2011). For example, Hughes (2020) studied the adaptation policies and documents in Detroit, Michigan, and Cleveland, Ohio, as the only major cities in the Great Lakes Region of the U.S. that have developed formal adaptation plans. The study discovered that social equity is somewhat addressed in the adaptation planning and policy tools because of growing poverty and inequality that is highlighted by extensive grassroots work. It also recognized that adaptation is not a top priority for local leaders, and there is a significant need for collaboration and partnerships if it is to work. In another study, Morris (2020) reviewed the literature on coastal adaptation approaches and argued that collaboration among stakeholders is necessary to facilitate adaptation at a regional level. Morris also introduced the Hampton Roads region as an example where stakeholder engagement has been instrumental in shaping an understanding of climate risk that informs climate adaptation.

Hernandez et al. (2018) analyzed the status of climate adaptation efforts as the response to more frequent and intense heatwaves and dust breaks in the Canary Islands; they discovered uncertainties in climate modelling, divergent opinions on the hazards and adaptation implementation, absence of epidemiological data, and lack of participation as the barriers to adaptation. In a recent study, Gussmann and Hinkel (2021) assessed the Maldives' SLR and coastal policy effectiveness, leveraging a study of policy documents and semi-structured

interviews with coastal policy experts and stakeholders. They concluded that existing coastal policies are not structured to effectively consider SLR.

Such studies have mainly focused on one governance level studying adaptation efforts from the perspective of a single city, region, or country. This study contributes to the existing literature by employing a multi-level approach that simultaneously probes policies across different levels of governance. Our paper proceeds as follows. First, we describe the methodology of our research in Section 2. In Section 3, we present our results and findings. We then discuss our findings and their policy implications in Section 4, followed by concluding remarks and avenues for future research in Section 5.

2. Methodology

In this study, we used a qualitative approach, mainly informed by interviews conducted with key stakeholders, along with analysis of the available documents, plans, and policies. Specifically, we used natural language processing to develop a keyword analysis method to inform our research questions and extract the main themes in the context of coastal climate risk adaptation policymaking. We then used content analysis to refine the themes to answer our research questions more accurately. This methodology provided a clear and comprehensive narrative about the evolution of policies and programmes and stakeholders' roles in this practice. We chose the City of Norfolk and the Hampton Roads region as our local and regional focal areas due to their pioneering role in Virginia's coastal adaptation and their national strategic significance.

We started our sampling by interviewing adaptation decision-makers in the City of Norfolk and expanded it to the regional and state governments through snowball sampling. During data collection, we were introduced to stakeholders from environmental NGOs, academia, and economic development nonprofits who have been involved in climate adaptation in Coastal Virginia. To understand comprehensively the adaptation practice, we also contacted stakeholders representing federal government agencies in Coastal Virginia, e.g. U.S. Army Corps of Engineers (USACE) and Military installations. We stopped the sampling when interviews reached a saturation point, where interviewees no longer provided new information or referred us to those we had already interviewed (Guest et al., 2006). Overall, we contacted 110 people via email, resulting in 42 interviews that were conducted between August 2021 and January 2022. We used two methods to analyze our data: keyword analysis based on Natural Language Processing (NLP) and thematic analysis through conventional content analysis introduced by Hsieh and Shannon (further explained in Supplementary Material – Section 1) (Hsieh & Shannon, 2005; Singh, 2018).

3. Results

Three themes emerged consistently from our interviews: stakeholders' perception of climate risks, the importance of policies and programmes for coastal adaptation at different governance levels, and the identification of influential stakeholders. We use these three themes to synthesize and present our findings in this section.

3.1. Perceptions of climate risks

Our interviewees identify flooding as the most observable and pressing climate risk in Coastal Virginia. The intensity and frequency of flooding have increased in the region within the last decade, igniting numerous calls for action. Extreme heat, hurricanes, and nor'easters[1] were also identified in some interviews, but with much less emphasis, mainly because their impacts are not directly observable or have not occurred in the region in the recent past.

Regarding awareness and response to climate risks, interviewees stated that it is challenging to draw attention to climate impacts such as SLR, particularly if the community is not directly exposed to this problem. It is also the case that the impacts of climate change are long-term and can be easily lost in the short-term political cycles and among other pressing issues. Resilience was the most used phrase referring to endeavours to address the impacts of climate change; some even use the term flooding resilience. However, our findings show that the meaning attributed to resilience varies across stakeholder groups. For example, resilience for

rural localities in the middle peninsula generally means fighting flooding and SLR to save their properties. In contrast, environmental nonprofits believe that government programmes, like home buyouts, should provide incentives to retreat from these properties because maintaining their status has negative consequences for water quality and nature conservation. Phrases addressing climate adaptation have changed through time. For example, recurrent flooding was the common phrase before SLR became politically acceptable in Virginia. Some individuals are still cautious about using climate change in their discussions as it is a sensitive political issue in Virginia. As another example, some environmental organizations prefer to use flooding instead of SLR, as it receives statewide attention, while SLR is mainly perceived as an issue for coastal areas. We refer readers to Supplementary Material – Section 2 for direct quotes from the interviews.

3.2. Policies at different governance levels

This section provides a narrative of coastal adaptation practice in Virginia by explaining the policies and programmes at different governance levels, as highlighted by our interviewees.

3.2.1. Local government

The City of Norfolk has been a pioneer in the region in recognizing challenges posed by climate change, and pursuing solutions and funding to tackle them, focusing on multi-level partnerships and community-based approaches. The extent and variety of involved stakeholders indicate that the practice of climate adaptation policymaking in Norfolk has been mainly a bottom-up process initiated by the local government while highly influenced by practices and expertise outside of the formal governance hierarchy (further illustrated in Supplementary Material – Section 4).

The first systematic effort to address climate change impacts in Norfolk dates to the late 2000s, when a cross-departmental committee was established to address the problem of more frequent and intense flooding, leading to the development of Norfolk's *Coastal Resilience Strategy* (City of Norfolk, 2014). The next significant step was Norfolk's selection to join the *100 Resilient Cities* (100RC) programme founded by the Rockefeller Foundation in 2013. This led to the formation of the Office of Resilience and Chief Resilience Officer (CRO) – which still exists after termination of the 100RC programme. This position reports directly to the city manager and has provided the city with various financial and technical resources to develop a comprehensive approach toward resilience (City of Norfolk, 2022). The result was '*Norfolk Vision 2100*', a long-term strategic vision for the city's future. *Vision 2100* is now part of the Norfolk Comprehensive Plan, guiding zoning, land use planning, and investment decision-making (City of Norfolk, 2021a). *Dutch Dialogues* have been another significant and successful initiative for climate adaptation through which experts from the Netherlands and their counterparts from Hampton Roads analyzed and recommended strategies for integrated water management for specific sites in the cities of Norfolk and Hampton (City of Norfolk, 2015). Dutch philosophy and the experience of 'living with water' rather than 'fighting the water' accompanied by a collaborative multidisciplinary design and focus on multi-purpose infrastructure have been the most important outcomes of the Dutch dialogues, which are still present in the language and endeavours of city staff in Norfolk.

Norfolk has utilized several policy tools: *Resilience quotient*, a zoning ordinance to encourage construction in safer areas, *Resilience Penny*, a recent allocation of property taxes to resilience endeavours, and *Community Rating System (CRS)*, a voluntary, federal programme in which participating communities receive discounts in flood insurance premiums depending on their involvement in the programme (City of Norfolk, 2021b; Commonwealth of Virginia - Office of the Governor, 2021; Simons et al., 2020). In addition to these policies, flood control infrastructure planning is guided by the *Norfolk Coastal Storm Risk Management Study*, performed by USACE in 2018 (USACE, 2018).

3.2.2. Regional government

The Hampton Roads Planning District Commission (HRPDC), one of the 21 Planning District Commissions (PDCs) in the Commonwealth of Virginia, is a regional organization representing the 17 local governments in the region on various issues, e.g. water and environment, economic development, emergency management, housing, and transportation (HRPDC, 2022). HRPDC is believed to be the lead PDC in Virginia to address SLR

and flooding mainly because it includes some of the most affected localities, such as Norfolk and Virginia Beach, who have been the pioneers of this practice in the state. HRPDC is involved in statewide policymaking by representing its member localities in various advisory committees, e.g. the Virginia Coastal Resilience Technical Advisory Committee (TAC)[2](Secretary of Natural and Historic Resources, 2021). Another mechanism for policy impact is to leverage the local members' delegation in the General Assembly or their representatives in Congress to push for policy agendas aligned with region needs. HRPDC formally releases policy suggestions through 'Position Statement' white papers (further explained in Supplementary Material – Section 4) (HRPDC, 2020c, 2020b, 2020a). A well-known policy measure adopted by HRPDC is the NOAA 2017 intermediate-high SLR projection scenario in 2018 (HRPDC, 2018). This decision was made to compensate for the lack of a statewide policy on SLR projection and to better coordinate the planning efforts of the localities.

The primary resilience-related arm of HRPDC is the *Coastal Resiliency Committee*, a group of representatives from member localities who discuss local efforts and plan for synergy potentials and joint projects at the regional level. The main achievements of this committee are: leading two *Joint Land Use Studies (JLUS)* focusing on SLR and persistent flooding (HRPDC, 2019b, 2021b), creating the *Hampton Roads Adaptation Forum* as a conversation medium for stakeholders in the Hampton Roads region to share experiences on SLR and flooding (Institute for Coastal Adaptation & Resilience (ICAR) 2021), creating *Get Flood Fluent* as an educational outreach programme to educate the public on the risks of flooding and flood insurance (HRPDC, 2019a), and developing the *Resilience Projects Dashboard* that provides significant amount of information on ongoing resilience projects (HRPDC, 2021a).

By the end of 2021, there were 592 projects with an estimated cost of $7.2 billion in the dashboard (summary of projects shown in Supplementary Material – Section 5). The most considerable portion of the cost (55%) is related to structural flood protection projects, indicating an emphasis on grey infrastructure projects in adaptation (HRPDC, 2021a). About 90% of projects are in the preconstruction phase, and 66% are in proposed status, indicating that climate adaptation has yet to yield significant construction in the Hampton Roads region.

3.2.3. State government

Figure 1 lists the main state-led policies to address climate change adaptation in Virginia. There are three significant efforts by the state government with a holistic and intergovernmental approach that evaluates risks and policy impacts across scales in the long-run (Eriksen et al., 2021; Kehler & Jeff Birchall, 2021). The first one dates back to the establishment of the '*Governor's Commission on Climate Change*' in Governor Kaine's

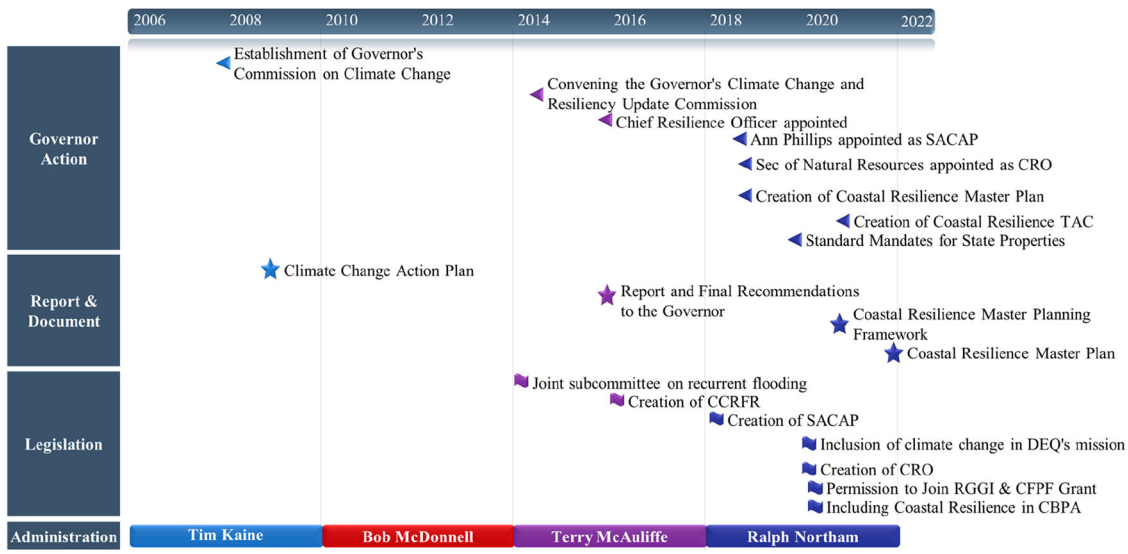

Figure 1. Main state-led policies to address climate adaptation in Virginia.

administration, which led to the '*Climate Action Plan*' in 2008 (Governor's Commission on Climate Change, 2008). Although the Climate Action Plan focused on climate mitigation, it addressed adaptation by recommending measures to assess the impacts of climate change, conserve nature, and include climate change in adaptation planning (further explained in Supplementary Material – Section 5). The second statewide effort was recognized in the Governor McAuliffe administration to determine what recommendations from the Climate Action Plan were implemented, provide new recommendations, and identify sources of funding to implement the new recommendations (Climate Change and Resiliency Update Commission, 2015; Commonwealth of Virginia - Office of the Governor, 2014). The General Assembly had two main pieces of adaptation-related legislation in the McAuliffe administration: the first was a joint subcommittee on recurrent flooding, which is still present, and the second was the creation of the Commonwealth Center for Recurrent Flooding Resiliency (CCRFR) to support the Commonwealth by conducting interdisciplinary resilience research (Virginia General Assembly, 2014, 2016).

The third and most significant statewide effort addressing flooding and SLR was during Governor Northam's Administration. This is aligned with the recurring theme in our interviews, that Virginia had not done much about resilience prior to Northam's administration, but was able to catch up to some extent, mainly because of an accumulation of experience, further clarity on the need for action, and particular emphasis from the governor, as suggested by our interviewees. Several Northam actions, usually through executive orders and several state-level laws, led to a statewide and intergovernmental effort to address the impacts of SLR and flooding. We observed a tendency to institutionalize the central point of contact for adaptation at the state level. For example, the General Assembly created a position called '*Special Assistant to the Governor for Coastal Adaptation and Protection (SACAP)*' to lead statewide coastal adaptation (Virginia General Assembly, 2018).

Coastal Resilience Master Plan (CRPM) and *Community Flood Preparedness Fund (CFPF)* are recognized as the most significant policies to address comprehensively climate adaptation in Coastal Virginia, both pursued through legislation and executive orders in Northam's administration (Commonwealth of Virginia - Office of the Governor, 2018, 2020, 2021). Led by the SACAP and the governor-appointed TAC, the Master Plan projected coastal flooding and its impact on infrastructure, estimated social vulnerability, established an inventory of existing resilience projects and a list of available funding options. This is believed to have been a promising first step toward state leadership in resilience. CFPF, a legislation by the General Assembly in 2020, is believed to have been the most significant allocation of state funds to climate resilience. The funds were acquired from Virginia's participation in the *Regional Greenhouse Gas Initiative* (RGGI) – a cooperative, market-based effort to cap and reduce CO_2 emissions from the power sector (RGGI, 2021), (Virginia General Assembly, 2020). Despite their potential significance, the future of the Master Plan and CFPF is uncertain as the current Governor, Glenn Youngkin, intends to withdraw Virginia from RGGI.

3.2.4. Federal government

Our participants believed that there is no comprehensive federal policy for SLR and flooding. However, there are some efforts in the Biden administration to address climate change impacts. We have identified a couple of these efforts to address climate change. First is the formation of the *National Climate Task Force* in January of 2021 through an executive order to assist in the organization and deployment of a government-wide initiative to tackle climate change impacts (The White House, 2021a). A few months later, the Task Force initiated the *Coastal Resilience Interagency Working Group (IWG)*, led by the Council on Environmental Quality (CEQ) and NOAA, to increase coastal resilience in the nation (The White House, 2021b). The Task Force and the Coastal Resilience IWG have great potential for setting policies and standards in the future.

Two unprecedented Acts will significantly impact climate adaptation since they provide billions of dollars for financing resilience projects around the nation. The *2022 Infrastructure Investment and Jobs Act* includes about $50 billion in funding for flooding, wildfires, coastal erosion, droughts, extreme events, and cybersecurity (Congress of the United States, 2021a). To be approved by the Senate, the *Build Back Better Act,* passed as the *Inflation Reduction Act of 2022,* is believed to be the most considerable effort to combat climate change in American history. Although it is mainly focused on climate mitigation, it has some resources for coastal restoration, soil conservation, and forest management (Congress of the United States, 2021b).

Type/Influence	Medium influence	High influence	Substantial influence
Local government	➢ Mayor ➢ Chief Resilience Officer (CRO)	➢ City council (Elected officials) ➢ City of Norfolk ➢ City of Virginia Beach	➢ Local legislators & executives
Regional government	➢ Northern Neck Planning District Commission (NNPDC)	➢ Middle Peninsula Planning District Commission (MPPDC)	➢ Hampton Roads Planning District Commission (HRPDC)
State government	➢ State Chief Resilience Officer (CRO) ➢ Virginia Department of Emergency Management (VDEM) ➢ Virginia Department of Transportation ➢ Virginia Department of Environmental of Quality (DEQ)	➢ Secretary of Natural Resources ➢ Virginia Department of Conservation and Recreation (DCR)	➢ Governor ➢ General Assembly ➢ Special Assistant to the Governor for Coastal Adaptation and Protection (SACAP)
Federal government	➢ FEMA ➢ National Fish and Wildlife Foundation ➢ National Oceanic and Atmospheric Administration (NOAA) ➢ Federal Highway Administration (FHWA) ➢ OMB	➢ USACE ➢ Department of Defense (DOD)	
Non-government	➢ Virginia Conservation Network (VCN) ➢ American Flood Coalition ➢ Pew Charitable Trusts ➢ Southern Environmental Law Center (SELC) ➢ Virginia Sea Grant ➢ Virginia Home Builders Association ➢ Shipbuilding industry ➢ Hampton Roads Alliance	➢ The Nature Conservancy ➢ Environmental Defense Fund ➢ Chesapeake Climate Action Network ➢ Old Dominion University ➢ Virginia Coastal Policy Center (VCPC) ➢ Dominion Energy	➢ Wetlands Watch ➢ Chesapeake Bay Foundation ➢ Virginia Institute of Marine Science (VIMS)

Figure 2. Most influential stakeholders.

3.3. Influential stakeholders

This section provides an overview of Virginia's most influential stakeholders in coastal adaptation policymaking based on our study participants' responses to the following question: 'Who are the most influential entities in coastal adaptation policymaking in Virginia?' The responses were categorized into the following three groups based on how many interviewees mentioned them: substantial influence (more than five in frequency), high influence (between three to five in frequency), and medium influence (one or two in frequency). The list, shown in Figure 2, includes stakeholders from the four governance levels considered previously as well as stakeholders from three non-governmental groups, i.e. environmental non-profits, academia, private sector. We observed an emphasis on the impact of state compared to other government stakeholders, indicating the important role of state legislation and execution as Virginia is a Dillon Rule[3] state (Russell & Bostrom, 2016). Three non-governmental organizations, two environmental nonprofits and an academic institution, are listed among highest influence, highlighting the essential role of nonprofits and academia as they help and influence multiple government levels through providing advice, education, data, and research (more information regarding non-government stakeholders is provided in Supplementary Material – Section 7). Figure 3 describes participants' opinions, summarized by the authors, on the main role and function for each stakeholder group, illustrating how each group of stakeholders influences adaptation policymaking.

4. Discussion

The main climate challenges in Coastal Virginia have been recurrent flooding and SLR. The practice of coastal adaptation policymaking in Virginia has been a bottom-up and fragmented process, without any dominant decision-makers, mostly initiated by resource-rich localities, and characterized by vast differences among localities in planning a response to such climate challenges. The cities of Norfolk and Virginia Beach were identified as the leading localities in adaptation due to the extent of planning, projects, and financial resources, whereas smaller and rural localities have not had the institutional, technical, and financial capacity to effectively plan their response. Such differences in developing and executing adaptation among localities would probably be observable in other states and regions. This speaks to a great need for state policymakers to assume a

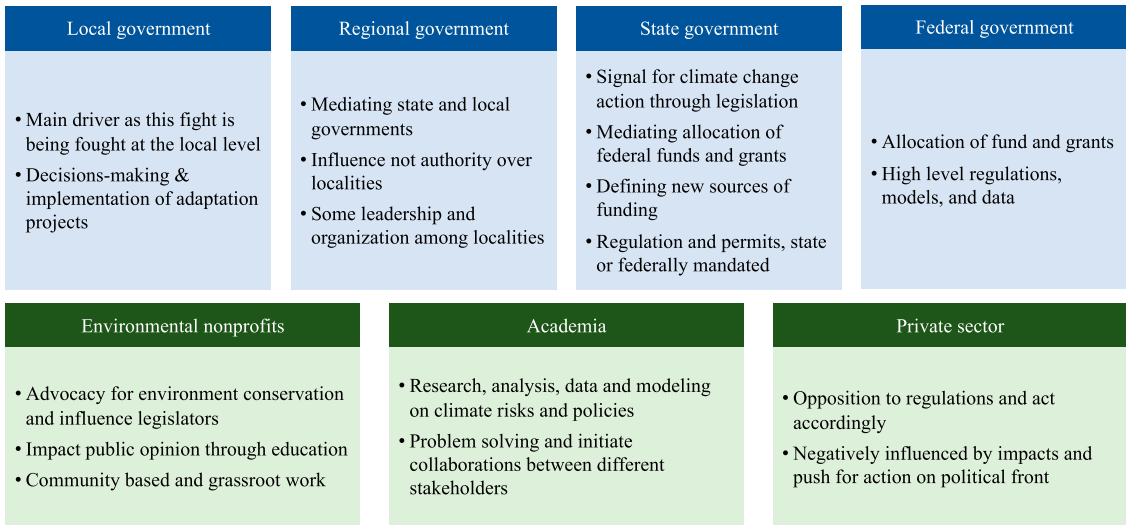

Figure 3. Main roles and functions of different stakeholder groups in adaptation policymaking.

stronger leadership, understand and measure such differences, and prioritize their resources to the most vulnerable localities in adaptation planning. Our research supports the need for state leadership, as our interviewees believed the state has substantial influence over laws, funding sources, and regulations with significant capacity for alignment across scales as portrayed in Section 3.3. Furthermore, long-lasting impacts of *100 Resilient cities* and *Dutch Dialogues* in Norfolk highlight the value of fostering cross-geographic coordination and capacity building programmes. It also confirms the importance of informal policy networks in learning and innovation within coastal areas (Kauneckis & Martin, 2020).

Some regional governments have played a role in synchronizing the efforts of their member localities. Due to their mandate, Planning District Commissions do not have authority over localities but can influence them by adding value to the ongoing local efforts. The regional efforts are also not uniform in Coastal Virginia, as HRPDC is known to be the most advanced entity, while others lag behind in planning for adaptation. Regional efforts have important lessons for other areas: first, there is potential for regional learning and collaboration if the localities of a region share similar problems that can benefit from economies of scale; this demonstrates the potential for policy diffusion (Schoenefeld et al., 2022). Moreover, regional efforts can drive policy formation in a broader context, such as at the state-level, as we observed in Hampton Roads. The regional efforts can also be a great mediator for harmonizing policymaking along multiple governance levels as they create incentives for both local and higher government levels to participate. The different performance of regional entities also suggests that to have successful regional collaboratives in areas with lower capacity, policymakers need to devise measures to boost technical and financial capabilities across the region and reward regional efforts through granting and funding mechanisms.

The Commonwealth of Virginia is perceived by the stakeholders to have been lagging in adaptation policymaking. The Northam administration made concerted efforts to bring climate adaptation to the forefront of policymaking through introducing several major state-level initiatives (e.g. Master Plan). While these initiatives require improvements and expansions, they are generally perceived as 'successful policies' for Coastal Virginia. However, the future of these efforts is uncertain as it is not clear how invested the incoming Youngkin administration is in addressing climate adaptation challenges. Indeed, we found that adaptation policymaking in Virginia has been influenced by political cycles with priorities drastically altered by each administration change, introducing significant uncertainty for continuation of policies. This phenomenon occurs in other areas of the world (Hamilton et al., 2016).

The lack of a comprehensive national-level policy on climate adaptation and the coordination challenges with federal programmes was an ongoing theme in this study. However, there have been recent efforts by

the federal government to coordinate climate adaptation programming at the national level. We observed that national policies and programmes set forth by federal agencies (e.g. infrastructure-focused legislation) can vastly affect local-level policies and decision-making. Besides allocating financial resources that can support local adaptation efforts, national-level policies can shape local priorities and encourage, or discourage, consideration of social equity and resilience of natural resources in climate adaptation. However, it is imperative for the federal government to ensure coordination across its agencies and those at the state and local levels, because adaptation is highly cross-functional and inter-governmental. It is also interesting that sub-national units, such as states, can learn from the adaptation experience of other units as we repeatedly heard of comparisons between Virginia and other states such as North Carolina, Louisiana, and Texas. It is crucial for states to learn from each other because of the iterative nature of adaptation and the accumulation of knowledge in different iterations of planning and execution.

5. Conclusion and future research

The main objective of this paper was to characterize adaptation policymaking in Coastal Virginia as a region of the U.S. experiencing significant impacts from climate change. This research can go further in different ways. We did not evaluate the effectiveness of extant climate adaptation policies. This is important future work. It would also be fruitful and necessary to identify and study knowledge gaps and barriers in the practice of adaptation policymaking in Coastal Virginia. This will inform future policymaking and planning efforts in different levels of governance. Such an analysis would be achievable by comparing similarities and differences in the role, risk perception, power and influence, and level of engagement among different stakeholder groups. The findings of our study can be instrumental in providing insights about the key stakeholders, revealing gaps and potential barriers to climate adaptation planning and implementation in Coastal Virginia. Future research can also focus on conducting a comparative analysis between coastal adaptation in Virginia and other coastal regions across the US to analyze the similarities and the differences that can contribute to well-informed national-level climate adaptation policymaking. Finally, this study can be extended by leveraging relevant theoretical frameworks to bring further insights about the adaptation policymaking and develop new planning perspectives for the future. For instance, Evolutionary Governance Theory (EGT) can help better understand the possibilities and limits of policymaking by highlighting the context of existing institutions and communities, which in turn can help determine what planning efforts could have greater potential for effective policymaking (Van Assche et al., 2013). Another example is the urban climate resilience framework, which can be leveraged to better understand the interactions and mutual influences of stakeholders by mapping and analyzing the interrelationships among systems, agents, and institutions (Tyler & Moench, 2012). Coastal Virginia, along with other jurisdictions at risk of sea-level rise, can benefit from such theoretically informed case studies that pave the way for more successful and consistent adaptation policies in the years to come. This case study provides insights and implications from Coastal Virginia's experience for broader adaptation policies around the globe.

Authors contribution

Sadegh Eghdami: Conceptualization, Methodology, Software, Formal analysis, Investigation, Resources, Data Curation, Writing – Original Draft, Visualization, Project administration. **Valerie Michel:** Conceptualization, Software, Investigation, Resources, Data curation, Writing – Review & Editing. **Majid Shafiee-Jood:** Validation, Writing – Review & Editing, Supervision. **Garrick Louis:** Conceptualization, Validation, Writing – Review & Editing, Supervision.

Notes

1. Storms caused by northeast winds along the East Coast of North America that most frequently happen between September and April (National Oceanic and Atmospheric Administration).

2. TAC included representatives of state agencies, regional PDCs, academic advisors, and environmental organizations to facilitate and coordinate the development of Coastal Resilience Master Plan.
3. Under Dillon Rule, local governments are created by the state and exist to perform the tasks of the state at the local level. So, the local government's power is derived from the state while limited to what the state delegates to it.

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